

6. ORGANOCHLORINE PESTICIDES

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6. ORGANOCHLORINE PESTICIDES AND RELATED COMPOUNDS

6.1 SUMMARY

Organochlorine (OC) pesticides (DDT, toxaphene, dieldrin, and chlordane) were widely used in the Central Valley until the 1970s. OC pesticide residue are still widespread in the Central Valley. Many OC pesticides have been banned over time. Because of their characteristics and behavior in the environment, however, residuals still are being detected through monitoring. This section addresses OC pesticides that are no longer used in California and other related compounds. Control of OC pesticides currently in use is the jurisdiction of the DPR. The OC pesticides are persistent in the environment and are characteristically associated with the organic component of small particles, such as in sediment. Also persistent in the environment are polychlorinated biphenyls (PCBs), which were used as a dielectric (an electric insulator); and dioxins and dioxin-like compounds, which are predominantly associated with combustion compounds containing chlorine. The body burden of OC pesticides, PCBs, and dioxins in aquatic organisms represents an integration of the routes by which that organism is exposed. Exposure can occur through the food chain, direct contact with water or sediments, or other routes. OC pesticides, PCBs, and dioxins are a concern to water quality because they tend to bioaccumulate and can be toxic or carcinogenic to aquatic species and humans. This section identifies OC pesticide concerns, OC pesticide levels found in the Delta, and proposed actions that can minimize impacts associated with these pesticides. PCB pollution is somewhat common in the urban environment and is also common in larger predatory fish. Dioxins and dioxin-like compounds are listed on the CWA Section 303(d) list for impairing the San Francisco Bay and part of the Bay-Delta. PCB and dioxin pollution and remediation will be further addressed by the CALFED Program as more is known and as experts can be assembled to address sources of impairment and remedial strategies.

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6.2 OBJECTIVE

The objective is to reduce concentrations of OC pesticides in biota in the San Joaquin and Sacramento Rivers and the Delta, which will require reducing the transport of OC pesticides from agricultural lands to the rivers. The measure of success will be lower levels of OC pesticides in biota as determined from



monitoring. PCB, dioxin, and dioxin-like compound concentrations and environmental (including public health) impacts will be monitored and solutions devised, if feasible.

6.3 PROBLEM DESCRIPTION

One of the most comprehensive sources of information to characterize problems associated with regionwide OC pesticides is the joint SWRCB/DFG Toxic Substances Monitoring Program (TSMP). Results from other important studies also are included in this report.

The TSMP has been monitoring pollutants in aquatic life since 1976. Twenty-two sites were monitored by the TSMP in the Bay-Delta watershed for 5 years. Of these sites, the Sacramento River near Hood and the San Joaquin River near Vernalis were monitored for 10 years. Most of the sites monitored revealed continually high levels of metals or OC pesticides in tissue samples. OC pesticides were widely used in the Central Valley in the 1950s and 1960s. Use has declined greatly since the early 1970s, and several OC pesticides have been banned. DDT was widely used as a general-purpose insecticide until it was banned by the EPA in 1972. DDT and its breakdown products, DDD and DDE, are very persistent and result in bioaccumulative toxic effects on fish and birds. Toxaphene replaced many DDT uses until it was banned for most uses in 1982. Dieldrin was banned for all uses except termite control in 1974, and banned for all uses in 1987. Chlordane was banned for all uses except termite control in 1983, and banned for all uses in 1988.

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Chlordane was found to exceed the 300 parts per billion (ppb) U.S. Food and Drug Administration's (FDA's) action level in channel catfish from the San Joaquin River near Vernalis and in carp from Paradise Cut near Tracy. DDT was found to exceed the FDA's action level of 5,000 ppb in channel catfish near Vernalis and in carp from Paradise Cut. DDT also was found at relatively high levels in carp from the Sacramento River near Hood. Concentrations of OC pesticides were generally much lower in bed sediment and biota in the Sacramento River Basin compared to the San Joaquin River Basin.

All fish fillet samples collected from the San Joaquin River near Vernalis from 1978 to 1987 exceeded recommended safe levels for fish-eating wildlife set by the National Academy of Science/National Academy of Engineering (NAS/NAE) for total DDT (the sum of DDD, DDE, and DDT), chlordane, and toxaphene. Fish fillet samples collected from the major east side tributaries to the San Joaquin River (the Merced, Tuolumne, and Stanislaus Rivers) also exceeded NAS/NAE-recommended levels for total DDT, chlordane, and toxaphene. Recently, the

toxaphene concentration in a whole carp from the Colusa Basin Drain in the Sacramento River Basin exceeded the NAS/NAE-recommended level.

Concentrations of OC pesticides in bed sediment and clams of west side tributaries were consistently higher than those in east side tributaries of the San Joaquin River. A 1998 USGS study concluded that concentrations of OC pesticides in biota, and perhaps in bed sediment of the San Joaquin Valley, have declined from the concentrations measured in the 1970s and 1980s but remain high compared to other regions of the United States.

In a study comparing winter storm transport of OC pesticides to irrigation season transport in the San Joaquin River Basin, instantaneous loads of OC pesticides at the time of sampling were substantially greater during the winter storm. However, due to the infrequent occurrence of sizable winter storms, overall transport was probably similar or greater during the irrigation season. As expected, most transport of OC pesticides during the winter storm runoff was in the suspended sediment. The suspended fractions (the ratio of OC pesticide concentration in suspended sediment in $\mu\text{g/l}$ to total OC pesticide concentration in the water column in $\mu\text{g/l}$) ranged from 0.52 to 0.98 for chlordane, dieldrin, total DDT, and toxaphene. With lower overland flow and streamflow velocities and subsequently lower suspended sediment concentrations during the irrigation season, the suspended fractions ranged from only 0.14 to 0.87 $\mu\text{g/l}$. Most calculated whole-water concentrations of p,p'-DDT, chlordane, dieldrin, and toxaphene during both the winter storm runoff and the irrigation season exceeded EPA's chronic criteria for the protection of fresh-water aquatic life.

PCBs were used in industry as a dielectric compound, such as in transformers in the municipal electric industry. PCBs are lipophilic (soluble in oils but not water) and persist in the environment. It is thought that most of the PCBs in the environment are in sediment. Fish tissue from the rivers and the Bay all contain levels of PCB. The levels vary, depending on the type and age of fish and the location of the habitat.

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These compounds are persistent in the environment even after they have been carried offsite and into the estuary. In some cases, not necessarily in the Bay-Delta, disturbed sediment reintroduces these compounds at high concentrations, which leads to fish kills and other impacts on habitat. It is unclear whether any mitigation is feasible on sediments for two reasons:

- Mitigation by removal would disturb sediment and create the very situation to be avoided.
- Costs associated with remediation would be prohibitive.

The impacts of allowing current levels of OC pesticides to reside in Bay-Delta sediment, coupled with long-term declines in pesticide levels in fresh sediment, should be weighed against other mitigation measures if the solutions presented here fail to meet the stated objective.

6.4 APPROACH TO SOLUTIONS

A large portion of the OC pesticide transport is associated with suspended sediment during both winter storm runoff and the irrigation season, especially for total DDT (suspended fraction of $0.87 \mu\text{g/l}$ in the irrigation season and $0.98 \mu\text{g/l}$ in winter storm runoff). Thus, a likely solution to reducing transport of OC pesticides to the San Joaquin and Sacramento Rivers is to reduce the transport of sediment from the agricultural fields, especially the fine-grained sediments from the west side of the valley. Irrigation season sediment losses are much easier to control than those due to winter storm runoff because the runoff from irrigation is contained within furrows and the water source causing the runoff is controllable.

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6.4.1 Priority Actions

1. It is recommended that CALFED support conservation efforts to help achieve the Water Quality Program objectives.

The conservation practices shown on the following page (either singly or in combination) have proven to be cost-effective methods of achieving significant water quality improvements through reducing tailwater runoff that contains sediments, pesticides, and nutrients to water bodies or conveyance systems in the area. When combined in a "whole-farm plan" as provided by the NRCS, additional benefits include reduced electrical energy consumption; improved water conservation; improved water infiltration; and, in some cases, improved air quality, improved biodiversity, and improved crop yields.

2. It is proposed that CALFED help support additional research on the widespread use of PAM as a BMP (and other related erosion-control agents) to control erosion and improve aquatic habitats.

A new conservation practice has been developed concurrently by the USDA Agricultural Research Service, UC Riverside, and UC Cooperative Extension. The use of high-quality polyacrylamide (water-soluble, anionic, high molecular weight PAM) as defined in the NRCS Field Office Technical Guide

virtually halts irrigation-induced erosion, eliminates sedimentation, and keeps farm chemical residues on the farm. PAM is added to irrigation water at rates less than 10 ppm and is strongly attracted to soil particles, which results in preserving soil structure, maintaining infiltration rates, and flocculating any soil particles that may become suspended. This practice results in reduced volumes of tailwater runoff that is sediment free, with virtually no residues leaving the farm.

Conservation Practices to Achieve Water Quality Improvements

Conservation Practice	Process	Effects	
Tailwater ditch tarps	Decreases slope	Reduces ditch erosion	Traps sediment
Land leveling	Decreases slope	Reduces water velocity	Reduces erosion
Cutback stream	Reduces runoff	Reduces water flow when water reaches furrow end	
Surge irrigation	Reduces runoff	Automates water management	Reduces erosion
Sprinkler germination	Reduces water	Eliminates pre-irrigation	Reduces erosion
Drip irrigation	Reduces water	Automates water management	Reduces erosion
Shorten length of run	Reduces stream	Reduces water volume	Reduces erosion
Gated surface pipe	Reduces runoff	Improves water management	Reduces erosion
Vegetated filter strip	Stabilizes soil	Reduces water velocity	Traps sediment
Cover crop	Stabilizes soil	Reduces water velocity	Reduces erosion
Grassed waterway	Stabilizes soil	Reduces water velocity	Reduces erosion
Conservation tillage	Stabilizes soil	Reduces water velocity	Reduces erosion
Sediment basin	Reduces runoff	Reduces water velocity	Traps sediment
Tailwater return system	Reduces water	Returns water to farm	Reduces sedimentation
Irrigation management	Reduces water	Improves water management	Reduces erosion
Nutrient management	Reduces inputs	Improves water management	Reduces runoff
Integrated pest management	Reduces inputs	Improves water management	Reduces runoff
Tailwater management	Reduces runoff	Improves water management	Reduces sedimentation

3. It is proposed that CALFED support projects that will recreate the stream channels and increase the size of flow structures, such as culverts, to help achieve reduction in OC pesticides.

Most of the BMPs listed above apply only to reducing the inputs of OC pesticides during the irrigation season and do not address the problem of winter storm transport. A few of the BMPs would be effective year-round (such as a vegetated filter strip, cover crop, and grassed waterway). In addition, some flooding occurs in west side tributaries to the San Joaquin River, especially in Hospital and Ingram Creeks, that may be preventable. The lack of channel capacity to carry even moderate winter storm runoff forces much of the flow onto freshly-plowed agricultural land. This greatly

increases the transport of sediment and OC pesticides to the San Joaquin River during winter storm events.

4. Financial incentive programs should be tied to a whole-farm approach that addresses water use, water quality, soil health and erosion, and reduced chemical use. This approach will avoid shifting environmental problems from one medium to another, and also will help focus resources on techniques with multiple benefits. The USDA program described in the West Stanislaus case study demonstrates that such an approach can be extremely effective in achieving water conservation and water quality benefits.

5. Strategies should be developed to implement conservation measures and fund local conservation efforts in the following manners:

- a. The state and federal governments should consider providing a permanent source of funding for RCD pollution prevention and resource conservation programs. RCDs are a valuable, underutilized resource. RCDs were formed as an independent local government liaison between the federal government and private landowners. When motivated and given the necessary resources, RCDs can play a valuable role in offering technical assistance and promoting sustainable farming practices. However, many RCDs have no source of income and are thus severely limited in the conservation assistance that they can offer.

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- b. The CALFED Program should condition the receipt of any Program benefits by agricultural water users on implementation of conservation measures, including water conservation and water quality benefits.
- c. Major engineering works, including urban development, inter-state highways, large canals, creek alignments and dams and diversions, geologic tectonic activity, and other changes in these landscapes, may contribute to additional erosion and sedimentation of the river systems and the Bay-Delta. These works should be examined.

- d. CALFED could contribute to an existing delivery system of “locally led conservation” through RCDs and NRCS, resulting in immediate positive water quality benefits. Farmers have responded positively to USDA’s new EQIP cost-share program, which provides for whole-farm planning and cost sharing to address the water quality resource concerns. This program is available throughout the CALFED area but is severely under-funded. Many existing high-priority applications will not be implemented because of the high expense of installing the measures and the limited NRCS funding.

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6. CALFED should monitor the environmental and public health impacts of PCBs in the Bay-Delta. If it appears that solutions to the pollution are feasible, a PCB Work Group could be formed to address possible solution strategies and CALFED's future involvement.

6.4.2 Information Needed

Projects that provide information needed should be supported based on priorities set by CALFED work groups and administration. Governmental and private efforts should be sought for contributions in this effort to control OC pesticide-laden sediment. Some potential projects include the following.

1. Data from continued monitoring efforts.

Scientific and technical needs associated with the problem of OC pesticides in the Bay-Delta and watershed include the need for continued monitoring of levels in biota and of sources in the basins. More data are needed on sources of OC pesticides in the Sacramento River Basin, similar to the information developed for the San Joaquin River Basin.

The TSMP continues to be one of the few overviews of the impacts of toxic substances in the environment. Regional elevations can be detected and put in perspective, although the TSMP is limited in detecting quickly changing types of contaminants or acutely toxic materials. Predatory fish are long lived and may travel considerable distances. A single fish with an elevated tissue concentration of a particular toxic substance cannot be linked with certainty to a potential source. However, repeated detections over many years in the same watershed can be revealing. Only through sustained monitoring can significant problems be distinguished from an isolated and highly contaminated individual specimen.

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The CMARP's support for the TSMP sampling site at Vernalis would offer the opportunity to examine fish whose body burdens of toxic substances integrate contaminants from all of the San Joaquin River tributaries. Whenever elevated levels of toxicants appear at Vernalis, additional samples from upstream of the San Joaquin River and its tributaries could be taken to trace the contaminant to a source region. Once a source region was determined, watershed-based source control efforts could be initiated.

2. Design and assessment of various BMPs to reduce OC pesticides.

A better understanding is needed of the effectiveness of various proposed BMPs to control sediment losses during the irrigation season. Some BMPs

also need to be developed to reduce sediment losses during winter storm runoff.

3. Relationship between soil fertility and pest management.

Additional research is needed on the relationship between soil fertility, pest management, and water use. Farmers in case studies found that soil fertility was key to reducing chemical inputs. Some also found that an extensive soil-building program could reduce water use.

4. Efficient irrigation technologies.

Additional research dollars should be directed toward improving efficient irrigation technologies. Continued advances in technology are possible and should be aggressively pursued.

5. Agricultural runoff and water quality stressors.

Continued research and technology transfer is needed to respond to increasing concerns related to surface water runoff from agricultural lands and their contribution to water quality stressors in the Delta.

6. Winter flood control and control of OC pesticide-laden sediment.

The relationship of OC pesticide control with flood control measures to protect farmland should be studied. Projects should be encouraged where flood control measures also control off-site migration of OC pesticides.

6.4.3 Existing Activities

The TSMP was designed to follow the fate of pesticides in the California environment. This cooperative program, involving DFG and the SWRCB, has been monitoring pollutants in aquatic life since 1978. Although procedures have changed over time, the program continues to characterize the degree to which aquatic organisms and food chains are exposed to toxic materials and contaminants.

Initially, benthic invertebrates, forage and predator fish, and sediments were analyzed at each site. Sediment sampling soon was dropped because of unsatisfactory results. Pollutants found during sediment analyses related more closely to the quantity of runoff from year to year than to the quantities emitted from point or non-point sources. Therefore, the program focused on the analysis of toxic contaminants in organisms. The body burden of toxic material in organisms represents an integration of the routes by which that organism is

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exposed to pollutants. A predatory fish, for example, may accumulate toxins directly through contact with the water or sediments, or by ingestion of smaller organisms with similar routes of accumulation.

The TSMP used several measures to put pollution in perspective. Human health concerns were reflected by using FDA MCLs, which would address concerns about the chronic human health effects of toxic substances consumed in foodstuffs. Wildlife concerns were assessed by considering the NAS/NAE-recommended maximum concentrations of toxic substances in fish tissue. Other reference levels were drawn from the United Nations Food and Agriculture Organization, and an internal standard reflecting elevated data from the range of samples collected during the program.

Since 1991, farmers in western Stanislaus County have participated in a very successful USDA water quality initiative project called the West Stanislaus Hydrologic Unit Area. The purpose of the project is to accelerate the voluntary implementation of BMPs through a locally led process, with financial, technical, and educational assistance from the USDA. Primary agencies include the West Stanislaus RCD, USDA Farm Service Agency, NRCS, and UC Cooperative Extension. Participation has grown to more than 25 local, state, and federal agencies that assist farmers in reducing off-site impacts from irrigation-induced erosion and sedimentation of the impaired San Joaquin River and Delta.

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The CVRWQCB funded the West Stanislaus Sediment Reduction Plan (PLAN) that (1) benchmarked existing conditions and solutions, (2) provided practical self-evaluation tools and BMPs, and (3) defined an implementation strategy. The PLAN documented that up to 95% of the sediment leaving farmed fields could ultimately reach the San Joaquin River. Several hundred copies of the PLAN have been distributed to farmers. The PLAN has been used as a template in similar landscapes in nearby counties with similar resource concerns. All conservation practices are well defined in the NRCS Field Office Technical Guide, as well as standards, specifications, and performance measures.

